Current Status of Fuel Cell Development in Japan

U.S. Eco-Energy 2002, Exhibition and Seminar, Keynote Speech by Dr. Takuya Homma, Executive Director of Fuel Cell Development Information Center, held on Feb/27/2002 at MIPRO International Exhibition Center, Sun-Shine City, Ikebukuro, Tokyo

In this speech, Dr. Takuya Homma overviewed the history and recent work on research and development of Fuel Cell technologies:

PAFC (Phosphoric Acid Fuel Cell)
PAFC is the first commercial fuel cell and 200 PAFC are now in operation in the world.
Kajima developed the methane production system from the waste sludge from wastewater treatment, livestock waste and/or waste garbage, using the methane fermentation.
In June/2001 at Kobe, the PAFC system, that uses methane produced by methane fermentation by the waste garbage from the hotel, has been in operation. The power generation capacity of this system is 100kw/h and treating the 6 ton/day waste garbage. Cost of the PAFC is 400,000 yen/kw.

MCFC (Molten Carbonate Fuel Cell)
This system could be used for the big capacity power generation. In 1999, the power generation system using this system succeeded the 5,000 hrs actual plant operation with 1,000kw/hr capacity (Outer Reformer Type) at Chubu Electric Power Co., and 5036 hrs actual plant operation with 200 kw/hr capacity (Internal Reformer Type) at Amagasaki of Kansai Electric Power Co., respectively. The target of this system is to increase the power generation efficiency up to 60 % combining with the gas turbine system.

SOFC (Solid Oxide Fuel Cell)
This system could achieve a high efficiency of 60% combining with the gas turbine system.
Chubu Electric Power Co., and Mitsubishi Heavy Industry has been studying SOFC from 1990, and succeeded to generate 15 kw power generation stack with 30 units of 200 mm square cell.
On the other hand, Kansai Electric Power Co., succeeded to generate the highest density power generation at low temperature with 0.9 W/cm2 at 700 deg C and 1.8 W/cm2 at 800 deg C.
The key technologies of SOFC are electrolyte, electrode.

Fuel Cell Battery with Co-generation for Household
The Japan Gas Association has been studying this system. The power generation capacity is 200w-3kw. The system consists of the following units, -fuel treating unit, PEFC system (fuel cell stack/inverter system), waste heat recovery and storage, back up system for hot water supply.
The fuel for this system will be natural gas, city gas, propane, and bio-gas.

FCV (Fuel Cell Vehicle)
Toyota, Honda and Nissan announced the new type FCVs. Most FCV use PEFC. The fuel used for FCV has wide range of selection such as methanol, ethanol, gasoline, natural gas and coal.
Toyota developed the FCV, in 1996 using hydrogen absorbed in hydrogen absorption metal, in 1997 using methanol, in 2001 'FCHV-4' using a high-pressure hydrogen that has maximum speed of 150 km/h and 250 km continuous run, in Oct/2001'FCHV-5' using CHF (clean hydro carbon).
Honda un-veiled, in 2001 FCX-V3 that use high pressure (250 atm) hydrogen and has maximum

speed of 80 km/h, in Sep/2001 'FCV-V4' that use high pressure (350 atm) hydrogen and has maximum speed of 140 km/h and 300 km continuous run.
Nissan also developed a hybrid FCV having PEFC and Li-ion battery.

Current Status of Fuel Cell Development in Japan (Cont.)

FCV (Fuel Cell Vehicle) (Cont.)

Mazda developed DEMIO FC-EV in 1997 and PREMACY FC-EV in 2001.
In 2002, the hydrogen supply station by using reformer of natural gas is in operation at Osaka, that produce 30 m3/h hydrogen and hydrogen storage system with hydrogen metal system and high-pressure hydrogen storage system.

Fuel Cell for Handy Phone and Portable Electric Equipment
Matsushita Electric Works developed a handy type PEFC that uses butane as fuel, is 65cm x 36 cm x 45 cm, 250 w capacity and 2hrs operation with two butane vessels.
The fuel cell for handy phone and PC is now great interest for Japanese Electric Equipment Manufacturer such as SONY, NEC etc. SONY developed Fullerene Proton Conducting Material that could be used for Fuel Cell. NEC developed DMFC that uses carbon nano horn as electrolyte.

Government Policy for Fuel Cell Development
Japanese Government announced that Japan accelerate R&D on the actual application of fuel cell, and realize the actual application of fuel cell to automobile and household equipment.
They expect the use of Fuel Cell will be 50,000 in year 2010, 5,000,000 in year 2020 for FCV, and 2,100,000 kw in year 2010, 10,000,000 kw in year 2020 for household equipment.

Conclusion

Although among major kinds of fuel cell system such as PAFC, MCFC, SOFC, and PEFC, PAFC is the only fuel cell being close to commercialization stage, it still needs large effort such as reducing the cost and exploiting the new market to reach at fully commercialization stage.

MCFC power plant has been under intensive development in Japan under the national project for the purpose of realizing it as a relatively large scale power plant combined with coal gasification and gas or steam turbine. The operational demonstration project of 1,000kW MCFC pilot plant with the external reformer and the 200kW plant with internal reformer were successfully completed by January 2000, and it is to be followed by the next phase of the national project.

SOFC is also expected to become a high efficient power plant in combination with coal gasification process, a gas turbine, or, and a steam turbine.

Major automotive companies succeed to develop and fabricate Fuel cell Vehicles using both hydrogen and methanol. There are, however, many difficulties to be overcome for the commercialization of FCV. Among them one of the most challenging problems seems to exist in the remarkable cost reduction of the fuel cell systems. Another important and strategic problem is supposed to be the deployment of infrastructure for fuel delivery to vehicles based on the choice of fuel.

The Japan Gas Association has been promoting the operational demonstration project on the PEFC co-generation system for the residential use in cooperation with major gas companies such as Tokyo, Osaka, and Toho gas under the sponsorship of NEDO.

I would like to conclude by saying the following remark.

In order to realize the commercialization of fuel cells, we still need to overcome many problems left behind. Among them, it seems to be the most important and challenging problem, in particular for transportation application, to manage the remarkable cost reduction. Assuring the reliability of fuel cell system is also very important.

In the circumstance of rapidly growing attention and expectation for the realization of fuel cells, many companies and institutions are now trying to participate in the fuel cell development fields from various directions. So it is impossible to describe the whole activities related to fuel cell development and deployment in Japan. I am afraid my presentation introduces only a part of these activities in Japan.